**GENETICS**

**Seventh Grade Science**

**2011-2012**

**Description**

Organisms can reproduce sexually (eukaryotes) and asexually (prokaryotes). Sexual

reproduction requires two parents who both provide genes to the new organism during

fertilization, resulting in offspring with a mix of inherited genes. In asexual reproduction, only

one parent is needed, and offspring are genetically identical to the parent. In both cases, the

genetic instructions necessary for development of offspring are contained inside the cell.

This genetic material is responsible for the traits passed on to offspring. These ideas of

heredity, or the passing of traits from parent to offspring, were first developed by the father

of genetics, Gregor Mendel. Chromosomes, found in the nucleus of eukaryotic cells, are

made up of genes, which in turn are made up of DNA, or deoxyribonucleic acid. The

information in DNA is a code made up of four chemical bases, and the order of these bases

is what determines how an organism grows and develops. DNA is arranged in two strips that

form a spiral called a double helix, first discovered through the combined efforts of Rosalind

Franklin, James Watson and Francis Crick. An important property of DNA is that it has the

ability to make copies of itself. This is important when cells divide because each new cell

needs to have an exact copy of the DNA from the old cell. Emphasis is placed on the

passing of traits from parent to offspring through replication of DNA during both asexual and

sexual reproduction, predicting the diversity of offspring, and problems encountered when

that DNA is miscopied. Emphasis is also placed on modeling DNA structure and replication.

Almost every cell in every living organism contains genetic material. The genetic code passed on by the parent determines the diversity of the offspring. Diversity makes it possible for organisms to grow and thrive in a variety of environments under a multitude of varying conditions. Later units will emphasize adaptations of organisms that make it best suited to living in particular ecosystems and biomes, as well as how these adaptations arise over many generations due to patterns of gene frequency and the process of natural selection.

**Enduring Understandings**

1. Organisms can be divided into two groups, prokaryotes (without a nucleus) and

eukaryotes (with a nucleus),

2. Organisms can reproduce asexually (prokaryotes) and sexually (eukaryotes).

3. During reproduction, genetic instructions are copied and passed on to offspring.

4. DNA is ultimately responsible for the traits passed on to offspring.

5. Dominance determines phenotypes of the offspring. A phenotype is the outward

expression of a trait.

6. Gregor Mendel is the father of genetics, and developed the Laws of Heredity.

7. DNA was discovered by James Watson and Francis Crick based on the studies of

Rosalind Franklin.

8. Mitosis produces identical cells, while meiosis produces unique cells. Crossover

during the prophase I stage of meiosis helps to ensure diversity of organisms that

sexually reproduce by producing cells that vary; in addition, meiosis produces

haploid cells.

9. Genetic mutations occur when DNA is altered during replication. DNA sequences

may be inserted into an existing DNA strand, deleted from an existing DNA strand, or

one sequence may be substituted for another in an existing DNA strand, all of which

result in a variance of traits.

**Essential Questions**

1. What are the similarities and differences between prokaryotes and eukaryotes?

http://www.diffen.com/difference/Eukaryotic\_Cell\_vs\_Prokaryotic\_Cell

1. What are the similarities and differences between sexual and asexual reproduction?

http://www.biotopics.co.uk/genes1/asexual\_and\_sexual\_reproduction.html

1. How are traits passed on from parent to offspring?

http://anthro.palomar.edu/mendel/mendel\_1.htm

1. Why do some traits show up more often than others?

Dominance

1. How are some traits combined to produce new traits?

http://www.sciencedaily.com/articles/e/evolution.htm

1. How does the process of meiosis help ensure genetic diversity?
2. In prophase I of meiosis the homologous chromosomes synapse and crossing over occurs. This switches sections of two of the sister chromatids so the outer two chromatids have the same mix of alleles as the parents and the inner two chromatids have new combinations of alleles.
3. Meiosis puts only one of each kind of chromosome in the gametes, selecting one of each homologous pair at random. Then when each gamete joins with the gamete from the other parent, there are practically infinite combinations of the alleles possible.

7. What constitutes genetic material and how is it formed?

The genetic material of a cell or an organism refers to those materials found in the [nucleus](http://www.biology-online.org/dictionary/Nucleus), [mitochondria](http://www.biology-online.org/dictionary/Mitochondria) and [cytoplasm](http://www.biology-online.org/dictionary/Cytoplasm), which play a fundamental role in determining the structure and nature of [cell](http://www.biology-online.org/dictionary/Cell) substances, and capable of self-propagating and [variation](http://www.biology-online.org/dictionary/Variation).

The genetic material of a cell can be a [gene](http://www.biology-online.org/dictionary/Gene), a part of a [gene](http://www.biology-online.org/dictionary/Gene), a group of [genes](http://www.biology-online.org/dictionary/Gene), a [DNA](http://www.biology-online.org/dictionary/DNA)

molecule, a [fragment](http://www.biology-online.org/dictionary/Fragment) of [DNA](http://www.biology-online.org/dictionary/DNA), a group of DNA molecules, or the entire [genome](http://www.biology-online.org/dictionary/Genome) of an

[organism](http://www.biology-online.org/dictionary/Organism).

DNA is made of an alternating phosphate and sugar molecules in a linked chain. The rungs of DNA come off sugar molecules and are called bases. There are four different types of bases. They are adenine, thymine, guanine, and cytosine or A, T, G, and C. Each rung is made of two linked bases. Only certain bases can link together (A to T and G to C).

9. What is a genetic mutation and how does it contribute to diversity?

A mutation is a permanent, heritable change in the nucleotide sequence in a [gene](http://www.biology-online.org/dictionary/Gene) or a [chromosome](http://www.biology-online.org/dictionary/Chromosome); the process in which such a change occurs in a [gene](http://www.biology-online.org/dictionary/Gene) or in a [chromosome](http://www.biology-online.org/dictionary/Chromosome).

<http://www.libraryindex.com/pages/2228/Genetics-Evolution-MUTATION.html>

10. Who are the major contributors to the discovery of concepts related to genetics?

Mendel, Franklin, Watson, Crick,

**Essential Concepts and Skills**

By the end of the unit, the student is expected to:

1. Compare and contrast prokaryotes and eukaryotes.

(above)

2. Compare and contrast asexual reproduction and sexual reproduction in both plants

and animals.

(above)

3. Analyze the methods by which genetic material is reproduced and passed on to

offspring.

(above)

4. Illustrate that chromosomes may be broken down into genes which are made up of

DNA.

(pic below, under chromosomes)

5. Explain the Laws of Heredity as proposed by Gregor Mendel.

**step.nn.k12.va.us**/science/Bio/biology\_ppt/mende.ppt

http://anthro.palomar.edu/mendel/mendel\_1.htm

1. Generate proof that some traits are dominant and some are recessive.

http://www.thetech.org/genetics/ask.php?id=22

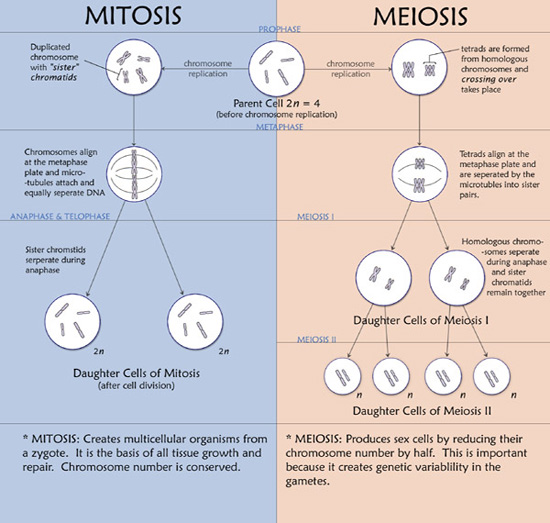
1. Predict the probability that certain traits will be present in offspring

<http://anthro.palomar.edu/mendel/mendel_2.htm>

1. Describe co-dominance and incomplete dominance.

(below, in the definitions)

1. Demonstrate the processes of mitosis and meiosis.



1. Justify why meiosis ensures diversity.

(#6, Above)

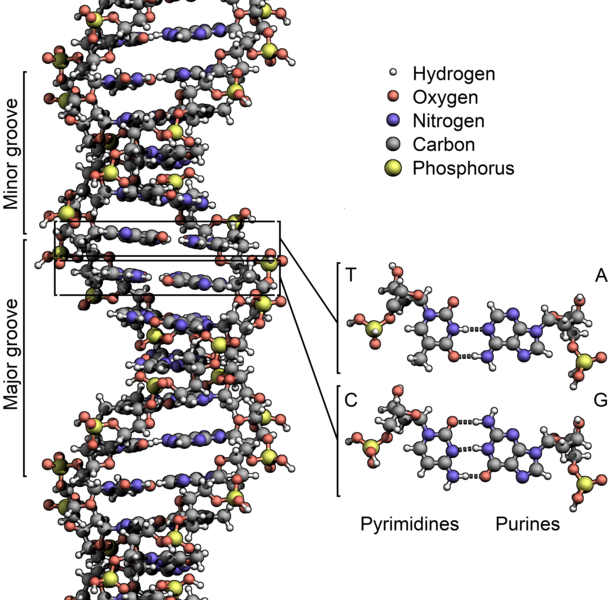
1. Model DNA’s double helix and assess why its structure enhances its function.

(Below, DNA )

http://www.ncbi.nlm.nih.gov/books/NBK26821/

12. Illustrate that DNA is formed from chemical base pairs which are attached to sugar

and phosphate molecules to form nucleotides.



13. Distinguish between insertion, deletion, and substitution during DNA replication, and

appraise the effects of subsequent mutations.

<http://employees.csbsju.edu/HJAKUBOWSKI/classes/SrSemMedEthics/Human%20Genome%20Project/DNA1.html>

Look under mutations, there is a chart under one of the links that helps

14. Evaluate the contributions of Gregor Mendel, Rosalind Franklin, James Watson, and

Francis Crick to the field of genetics.

<http://www.nobelprize.org/educational/medicine/dna_double_helix/readmore.html>

**What do students typically have as misconceptions?**

1. Daughters inherit most characteristics from their mothers, and boys inherit most from their fathers.

B) Sexual reproduction occurs in animals but not in plants.

C) Alleles and genes are the same thing.

D) Each box in a Punnett square represents a trait of one offspring, rather than a

probability that the trait will show up.

E) DNA, genes, and chromosomes are separate structures inside the cell.

**Preconception Survey**

1. Why do children look like their parents?
2. How can a child have red hair, when neither parent has red hair?
3. What is DNA and where is it found?
4. How do plants reproduce?

**Formative Assessment Items**

1. Use microscopic models to distinguish between prokaryotes and eukaryotes

2. Use microscopic models to distinguish between mitosis and meiosis.

3. Use a DNA model to demonstrate replication, as well as insertion, deletion, and

substitution.

4. Predict traits of offspring using Punnett Squares.

5. Grow three generations of plants in order to identify patterns of inheritance.

**TEKS Covered 7.14 Organisms and environments.** The student knows that reproduction is a characteristic of living organisms and that the instructions for traits are governed in the genetic material. The student is expected to:

**College Board Standards Covered LSM-PE.5.1.1** Describe the problem or scientific question that various scientists investigated and the scientists’ contributions to the development of the model of inheritance toward modern genetics. *[****BOUNDARY:*** *It is suggested that students study Mendel, Watson and Crick, and Franklin; students can, but do not have to, study Sutton and Bateson.]*

**LSM-PE.5.1.2** Observe patterns (similar to those observed by Mendel), using data from parent–generation crosses, in traits of parents and offspring.

**LSM-PE.5.1.3** Give examples of various scientists whose ideas built upon and/or revised Mendel’s model of inheritance.

**LSM-PE.5.2.1** Evaluate consistency and accuracy of representations illustrating the major components of the Watson–Crick double-helix model of DNA.

**LSM-PE.5.2.2** Construct a representation of DNA replication, showing how the helical DNA molecule unzips and how nucleotide bases pair with the DNA template to form a duplicate of the DNA molecule.

**LSM-PE.5.2.3** Construct a representation that shows what happens to the chromosomes of the parent organisms during both the process of fertilization and the first stages of cell division of a zygote.

**LSM-PE.5.2.4** Explain and justify, using representations, why the DNA of the daughter cells of asexually reproducing organisms are identical to the DNA of parent cells. Explanation and justification are based on knowledge of the mechanisms (e.g., asexual reproduction, DNA replication) of DNA transmission from generation to generation in asexually reproducing organisms.

A) defineheredityasthepassageofgeneticinstructionsfromonegenerationtothe

next generation.

B) comparetheresultsofuniformordiverseoffspringfromsexualreproductionor

asexual reproduction. ***Supporting Standard-Category 4***

C) recognize that inherited traits of individuals are governed in the genetic material

found in the genes within chromosomes in the nucleus. ***Supporting Standard-***

***Category 4***

**LSM-PE.5.2.5** Explain and justify why the DNA of the offspring of sexually reproducing organisms are not identical to the DNA of either parent organism. Explanation and justification are based on knowledge of the mechanisms (e.g., fertilization, cell division) of DNA transfer between generations in sexually reproducing organisms.

**LSM-PE.5.4.1** Describe three ways (e.g., insertion, deletion or substitution) that changes in DNA (mutations) can occur during replication.

**LSM-PE.5.4.2** Predict and justify, based on the type of cell, whether a particular error in copying DNA during replication will be transmitted to the offspring.

Dominance - in [genetics](http://en.wikipedia.org/wiki/Genetics) is a relationship between two variant forms ([alleles](http://en.wikipedia.org/wiki/Allele)) of a single [gene](http://en.wikipedia.org/wiki/Gene), in which one allele masks the effect of the other in influencing some trait. In the simplest case, if a gene exists in two allelic forms (*A* & *a*), three combinations of alleles ([genotypes](http://en.wikipedia.org/wiki/Genotypes)) are possible: *AA*, *Aa*, and *aa*. If *Aa* individuals ([heterozygotes](http://en.wikipedia.org/wiki/Zygosity)) show the same form of the trait ([phenotype](http://en.wikipedia.org/wiki/Phenotype)) as *AA* individuals ([homozygotes](http://en.wikipedia.org/wiki/Zygosity)), and *aa* homozygotes show a different phenotype, allele *A* is said to *dominate* or *be dominant to* allele *a*, and *a* is said to *be recessive to* *A*.

Fertilization -The process by which two gametes (reproductive cells having a single, haploid set of chromosomes) fuse to become a zygote, which develops into a new organism. The resultant zygote is diploid (it has two sets of chromosomes)

Sexual reproduction- is the creation of a new organism by combining the [genetic](http://en.wikipedia.org/wiki/Genetics) material of two organisms. The two main processes are: [meiosis](http://en.wikipedia.org/wiki/Meiosis), involving the halving of the number of [chromosomes](http://en.wikipedia.org/wiki/Chromosome); and [fertilization](http://en.wikipedia.org/wiki/Fertilization), involving the fusion of two [gametes](http://en.wikipedia.org/wiki/Gamete) and the restoration of the original number of chromosomes.

Inherit- to receive a genetically controlled [characteristic](http://www.science-dictionary.com/definition/characteristic.html) from a [parent](http://www.science-dictionary.com/definition/parent.html)

Heredity- the [transfer](http://www.science-dictionary.com/definition/transfer.html) of genetically controlled [characteristics](http://www.science-dictionary.com/definition/characteristic.html) from [parent](http://www.science-dictionary.com/definition/parent.html) to [offspring](http://www.science-dictionary.com/definition/offspring.html)

Diversity- the [richness](http://www.science-dictionary.com/definition/richness.html) of the [number](http://www.science-dictionary.com/definition/number.html) of [species](http://www.science-dictionary.com/definition/species.html)

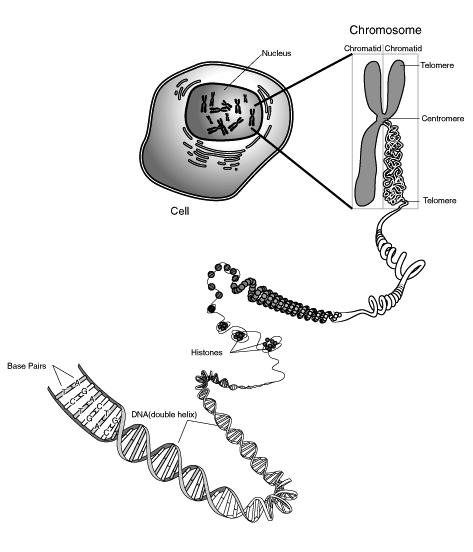
Gregor Mendal- the founder of the new science of [genetics](http://en.wikipedia.org/wiki/Genetics)

Rosalind Franklin- made critical contributions to the understanding of the fine molecular structures of [DNA](http://en.wikipedia.org/wiki/DNA), [RNA](http://en.wikipedia.org/wiki/RNA), [viruses](http://en.wikipedia.org/wiki/Viruses), [coal](http://en.wikipedia.org/wiki/Coal) and [graphite](http://en.wikipedia.org/wiki/Graphite).[1] The [DNA](http://en.wikipedia.org/wiki/DNA) work achieved the most fame because DNA (deoxyribonucleic acid) plays essential roles in cell metabolism and [genetics](http://en.wikipedia.org/wiki/Genetics), and the discovery of its structure helped scientists understand how genetic information is passed from parents to children

James Watson- one of the co-discoverers of the structure of [DNA](http://en.wikipedia.org/wiki/DNA) in 1953 with [Francis Crick](http://en.wikipedia.org/wiki/Francis_Crick)

Francis Crick- most noted for being one of two co-discoverers of the structure of the [DNA](http://en.wikipedia.org/wiki/DNA) [molecule](http://en.wikipedia.org/wiki/Molecule) in 1953, together with [James D. Watson](http://en.wikipedia.org/wiki/James_D._Watson).

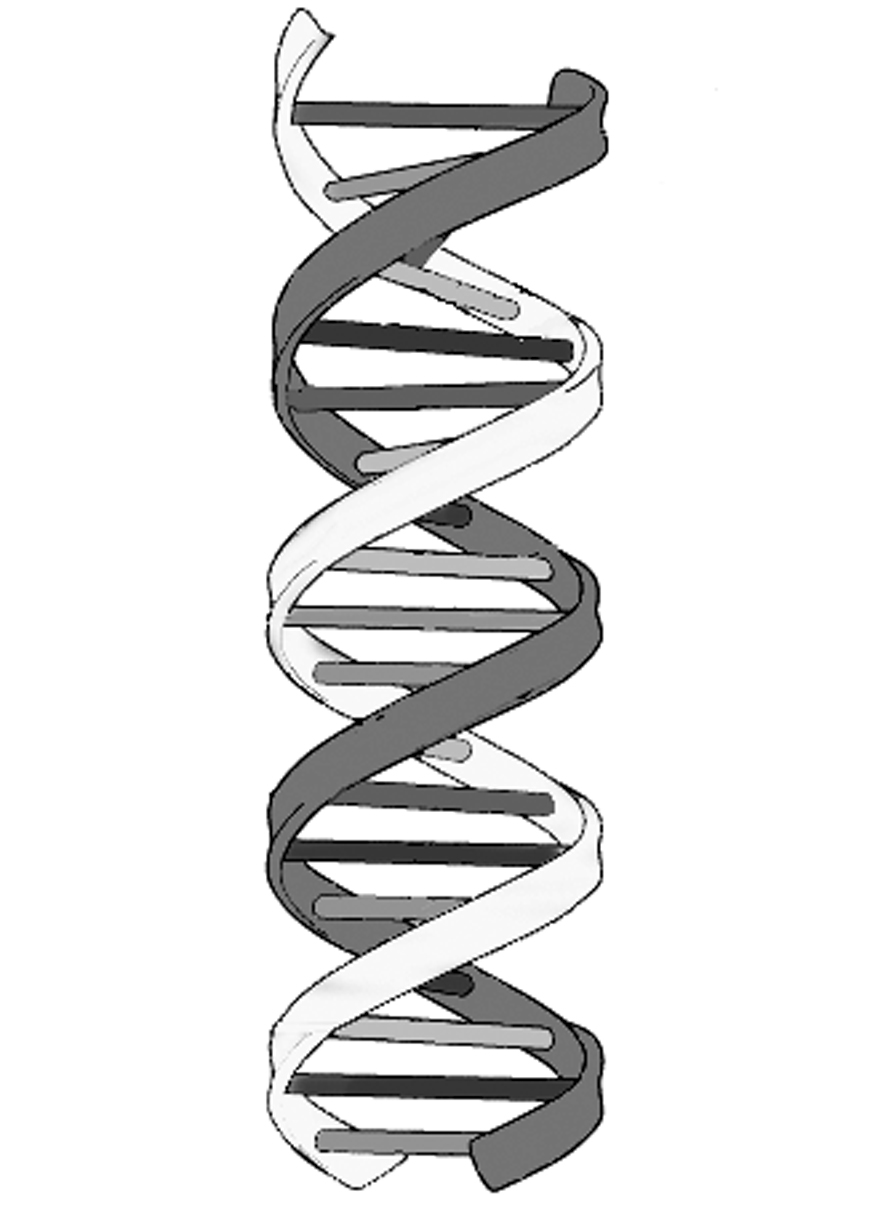
Chromosomes- A [structure](http://www.biology-online.org/dictionary/Structure) within the [cell](http://www.biology-online.org/dictionary/Cell) that bears the [genetic material](http://www.biology-online.org/dictionary/Genetic_material) as a threadlike linear [strand](http://www.biology-online.org/dictionary/Strand) of [DNA](http://www.biology-online.org/dictionary/DNA) bonded to various [proteins](http://www.biology-online.org/dictionary/Proteins) in the [nucleus](http://www.biology-online.org/dictionary/Nucleus) of [eukaryotic](http://www.biology-online.org/dictionary/Eukaryotic) [cells](http://www.biology-online.org/dictionary/Cell), or as a circular [strand](http://www.biology-online.org/dictionary/Strand) of [DNA](http://www.biology-online.org/dictionary/DNA) (or [RNA](http://www.biology-online.org/dictionary/RNA) in some [viruses](http://www.biology-online.org/dictionary/Virus)) in the [cytoplasm](http://www.biology-online.org/dictionary/Cytoplasm) of [prokaryotes](http://www.biology-online.org/dictionary/Prokaryotes) and in the [mitochondrion](http://www.biology-online.org/dictionary/Mitochondrion) and [chloroplast](http://www.biology-online.org/dictionary/Chloroplast) of certain [eukaryotes](http://www.biology-online.org/dictionary/Eukaryotes).



Nucleus- The large, membrane-bounded [organelle](http://www.biology-online.org/dictionary/Organelle) that contains the [genetic material](http://www.biology-online.org/dictionary/Genetic_material), in the form of [multiple](http://www.biology-online.org/dictionary/Multiple) [linear](http://www.biology-online.org/dictionary/Linear) [DNA](http://www.biology-online.org/dictionary/DNA) [molecules](http://www.biology-online.org/dictionary/Molecule) organized into [structures](http://www.biology-online.org/dictionary/Structure) called [chromosomes](http://www.biology-online.org/dictionary/Chromosomes).

DNA- A double-stranded [nucleic acid](http://www.biology-online.org/dictionary/Nucleic_acid) that contains the genetic information for [cell growth](http://www.biology-online.org/dictionary/Cell_growth), [division](http://www.biology-online.org/dictionary/Division), and [function](http://www.biology-online.org/dictionary/Function).

Double Helix Model- A [conformation](http://www.biology-online.org/dictionary/Conformation) or shape describing a [structure](http://www.biology-online.org/dictionary/Structure) that typically consists of two matching helices intertwined about a common [axis](http://www.biology-online.org/dictionary/Axis), such as the structure of the [DNA](http://www.biology-online.org/dictionary/DNA) [molecule](http://www.biology-online.org/dictionary/Molecule), which is made of two linear strands held together in opposite direction through chemical bonds, and which has become twisted into a [helix](http://www.biology-online.org/dictionary/Helix) (that is a three-dimensional spiral *similar to the shape of a railing on a spiral staircase*).



Deoxyribonucleic Acid- (DNA) A double-stranded [nucleic acid](http://www.biology-online.org/dictionary/Nucleic_acid) that contains the genetic information for [cell](http://www.biology-online.org/dictionary/Cell) growth, division, and function

Reproduction - The [production](http://www.biology-online.org/dictionary/Production) of offspring by organised [bodies](http://www.biology-online.org/dictionary/Bodies).

Allele- One [member](http://www.biology-online.org/dictionary/Member) of a [pair](http://www.biology-online.org/dictionary/Pair) (or any of the series) of [genes](http://www.biology-online.org/dictionary/Gene) occupying a specific spot on a [chromosome](http://www.biology-online.org/dictionary/Chromosome) (called [locus](http://www.biology-online.org/dictionary/Locus)) that controls the same [trait](http://www.biology-online.org/dictionary/Trait). (Aa, AA, aa) Each “A or a” is an Allele)

Genes- The [fundamental](http://www.biology-online.org/dictionary/Fundamental), [physical](http://www.biology-online.org/dictionary/Physical), and [functional](http://www.biology-online.org/dictionary/Functional) [unit](http://www.biology-online.org/dictionary/Unit) of [heredity](http://www.biology-online.org/dictionary/Heredity).

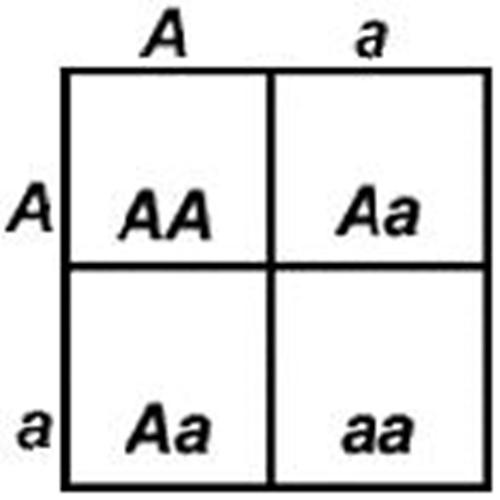
Phenotype- The [physical](http://www.biology-online.org/dictionary/Physical) [appearance](http://www.biology-online.org/dictionary/Appearance) or [biochemical](http://www.biology-online.org/dictionary/Biochemical) [characteristic](http://www.biology-online.org/dictionary/Characteristic) of an [organism](http://www.biology-online.org/dictionary/Organism) as a result of the [interaction](http://www.biology-online.org/dictionary/Interaction) of its [genotype](http://www.biology-online.org/dictionary/Genotype) and the [environment](http://www.biology-online.org/dictionary/Environment). (what it looks like)

Genotype- The entire set of [genes](http://www.biology-online.org/dictionary/Genes) in an [organism](http://www.biology-online.org/dictionary/Organism). The genetic makeup of an individual.

Dominant- An [allele](http://www.biology-online.org/dictionary/Allele) or a [gene](http://www.biology-online.org/dictionary/Gene) that is expressed in an [organism](http://www.biology-online.org/dictionary/Organism)’s [phenotype](http://www.biology-online.org/dictionary/Phenotype), masking the effect of the [recessive](http://www.biology-online.org/dictionary/Recessive) [allele](http://www.biology-online.org/dictionary/Allele) or [gene](http://www.biology-online.org/dictionary/Gene) when present. (Aa, A is dominant)

Recessive- A [gene](http://www.biology-online.org/dictionary/Gene) that is expressed only when it is [present](http://www.biology-online.org/dictionary/Present) in two copies or if the other copy is missing (Aa, a is recessive)

Punnett Square- A tool that helps to show all possible [allelic](http://www.biology-online.org/dictionary/Allelic) combinations of [gametes](http://www.biology-online.org/dictionary/Gametes) in a [cross](http://www.biology-online.org/dictionary/Cross) of parents with known [genotypes](http://www.biology-online.org/dictionary/Genotype) in order to predict the probability of their [offspring](http://www.biology-online.org/dictionary/Offspring) possessing certain sets of [alleles](http://www.biology-online.org/dictionary/Alleles).



Co-dominance- A [condition](http://www.biology-online.org/dictionary/Condition) in which the [alleles](http://www.biology-online.org/dictionary/Alleles) of a [gene pair](http://www.biology-online.org/bodict/index.php?title=Gene_pair&action=edit) in a [heterozygote](http://www.biology-online.org/dictionary/Heterozygote) are fully expressed thereby resulting in [offspring](http://www.biology-online.org/dictionary/Offspring) with a [phenotype](http://www.biology-online.org/dictionary/Phenotype) that is neither [dominant](http://www.biology-online.org/dictionary/Dominant) nor [recessive](http://www.biology-online.org/dictionary/Recessive).

**\* Red Flower x White Flower = Red Flower with White spots**

Incomplete dominance- A kind of [dominance](http://www.biology-online.org/dictionary/Dominance) occurring in [heterozygotes](http://www.biology-online.org/dictionary/Heterozygote) in which the [dominant](http://www.biology-online.org/dictionary/Dominant) [allele](http://www.biology-online.org/dictionary/Allele) is only partially expressed, and usually resulting in an [offspring](http://www.biology-online.org/dictionary/Offspring) with an [intermediate](http://www.biology-online.org/dictionary/Intermediate)

**\*Red Flower x White Flower = Pink Flower**

Prokaryotic- Of, or pertaining to, or characteristic of a [prokaryote](http://www.biology-online.org/dictionary/Prokaryote), which is basically an [organism](http://www.biology-online.org/dictionary/Organism) lacking a *true* [nucleus](http://www.biology-online.org/dictionary/Nucleus).

Eukaryotic- Of, or pertaining to, or characteristic of a [eukaryote](http://www.biology-online.org/dictionary/Eukaryote), which is basically an organism possessing a membrane-bound [nucleus](http://www.biology-online.org/dictionary/Nucleus).

Mendels Law of Heredity- A set of generalizations based on Gregor Mendel's published scientific works that attempts to explain heredity and inheritance pattern. These generalizations include the [Law of Segregation](http://www.biology-online.org/dictionary/Law_of_Segregation) and the [Law of Independent Assortment](http://www.biology-online.org/dictionary/Law_of_Independent_Assortment) as his summaries from his empirical findings and statistical analysis through his botanical breeding experiments.

Meiosis- The first of the two consecutive divisions of the [nucleus](http://www.biology-online.org/dictionary/Nucleus) of [eukaryotic cell](http://www.biology-online.org/dictionary/Eukaryotic_cell) during [meiosis](http://www.biology-online.org/dictionary/Meiosis), and composed of the following stages: [prophase I](http://www.biology-online.org/dictionary/Prophase_I), [metaphase I](http://www.biology-online.org/bodict/index.php?title=Metaphase_I&action=edit), [anaphase I](http://www.biology-online.org/bodict/index.php?title=Anaphase_I&action=edit), and [telophase I](http://www.biology-online.org/bodict/index.php?title=Telophase_I&action=edit).

Mitosis- The process where a [single](http://www.biology-online.org/dictionary/Single) [cell](http://www.biology-online.org/dictionary/Cell) divides resulting in generally two identical [cells](http://www.biology-online.org/dictionary/Cells), each containing the same number of [chromosomes](http://www.biology-online.org/dictionary/Chromosomes) and genetic content as that of the original [cell](http://www.biology-online.org/dictionary/Cell).

Mutation- A permanent, heritable change in the nucleotide sequence in a gene or a chromosome; the process in which such a change occurs in a gene or in a chromosome.

<http://www.biology-online.org/>

<http://www.hobart.k12.in.us/jkousen/Biology/inccodom.htm>

<http://www.ba-education.com/for/science/dnabiology.html>